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RMRS

ADMIN RECORD

INTEROFFICE CORRESPONDENCE

DATE: November 14, 1995

TO: E. C. Mast, RMRS, Environmental Projects Group, x8589

FROM: R. G. Smith, Jr., RMRS, Hydrogeology, x7898

SUBJECT: SUMMARY OF GEOLOGIC AND HYDROGEOLOGIC CONDITIONS AT IHSS 165 RGS-013-95

At your request, I have prepared a brief summary of the geologic and hydrogeologic conditions for the IHSS 165 area. My examination of the available database indicates that, despite a considerable amount of existing data in this area, there is an insufficient amount of certain geologic and hydrogeologic data for an adequate understanding of IHSS 165 for Waste Management Facility (WMF) siting and monitoring program design purposes. Specifically, the presence and extent of groundwater associated with a shallow, permeable bedrock sandstone needs further resolution in order to properly assess groundwater flow paths and design an effective monitoring well network. This deficiency is discussed in the last section of the memorandum.

The majority of information gathered for this summary came from the OU4 Proposed IM/IRA-EA Decision Document and OU6 draft RI/RFI reports. Additional information was retrieved from various other sources, including the OUs 1, 2 and 5 RI/RFI reports and Site-Wide Geoscience Characterization Study report series.

Lithology and Geologic Structure

The proposed WMF is situated in an upland area occupied entirely by the Rocky Flats alluvium and flanked to the north and south by colluvium-covered valley slopes of the Walnut and South Walnut Creek drainages. The composition of the Rocky Flats alluvium at the site is typical of most areas at RFETS with clayey and silty sand and gravels comprising the bulk of the underlying unconsolidated material. Bedrock materials consist chiefly of weathered and unweathered claystone and silty claystone with discontinuous beds of siltstone and fine to medium grained sandstone. The coarser-grained sandstones have tentatively been identified as the Arapahoe No. 1 sandstone in the OU6 draft RI/RFI report. Two geologic cross-sections and a cross-section location map are provided from the OU4 and OU6 reports that illustrate the geologic setting of IHSS 165 in north-south and east-west orientations (see Figures II.3.5-7, II.3.5-8 and 3.9-5 attached).

Aspects of the geologic structure that are most relevant to IHSS 165 include an inferred north-south oriented bedrock fault that traverses the solar pond area west of the IHSS, and the configuration of the bedrock surface. The location of the fault in a hydraulically upgradient direction from the IHSS removes it as a potential groundwater pathway, but may affect the geotechnical design criteria. Figure II.3.5-13, Bedrock Paleotopography, from the OU4 Proposed IM/IRA-EA Decision Document illustrates the major features of the bedrock surface (see attached).

Depth to Bedrock

The depth to bedrock ranges from less than five feet near the west center of the IHSS (boring 73092) to over 20 feet in the southeast corner at boring 72792 with an estimated average depth of about 10 feet. Figure II.3.5-1, Well and Boring Location Map, illustrates the position of these borings at IHSS 165.

Groundwater Occurrence and Distribution

Groundwater has been found in all hydrostratigraphic units underlying the site, however only the unconsolidated surficial deposits (Rocky Flats alluvium and colluvium) and bedrock weathered zone (including the Arapahoe No. 1 sandstone) are considered permeable enough to facilitate significant contaminant transport. Groundwater movement in the surficial deposits and No. 1 sandstone occurs mainly as intergranular flow while fracture flow is assumed to predominate in weathered claystones and other consolidated fine-grained media.

The Rocky Flats alluvium underlies the entire area of IHSS 165, but is variably saturated. Experience gained from hydrogeologic investigations conducted at OUs 1, 2, and 5 have indicated that the hydrogeology of discontinuously saturated upland and hillslope areas at RFETS is complex and often unpredictable. The lateral extent of saturated alluvium is seasonal being more extensive during late spring and least extensive during late winter.

Weathered bedrock is expected to play an increasingly important role as a contaminant pathway in areas of limited or no alluvial saturation. The weathered bedrock is assumed to be partially saturated and laterally continuous. Flow in fractured claystones is probably minimal due to low hydraulic conductivities and low horizontal hydraulic gradients.

The No. 1 sandstone is found over much of the eastern half of the site, and is known to subcrop beneath the alluvium just west of the perimeter security fence (see Figure II.3.5-16 attached). The actual extent and thickness of the sandstone in unknown because no wells or borings are fully penetrating, but the thickness is at least 12 feet in one boring. Figure II.3.5-16 indicates that the No. 1 sandstone may subcrop (and discharge) in both the Walnut and South Walnut Creek drainages.

Saturated Thickness

The saturated thickness for surficial deposits in the IHSS 165 area ranges from 0 to about 10 feet (April 1993) with the thicker areas found mainly in depressions and channels associated with the bedrock surface. Areas of discontinuous, seasonally dry alluvium tend to occur over much of the site, especially to the northwest and east along bedrock highs. Drainage of alluvial groundwater into the No. 1 sandstone may also account for the dry alluvial conditions in the eastern part of the site.

The saturated thickness of the No. 1 sandstone is unknown due to uncertainty regarding the total thickness of the unit. The total thickness of the weathered bedrock zone is estimated to be about 30 feet (Plate 5-12, 1995 Geologic Characterization Report), which implies a potential saturated thickness of between 20 to 25 feet.

Water Table Fluctuations and Historical Highs

Historically, the water table at IHSS 165 has fluctuated over a range of 0 (well 76192) to 8.1 feet (well P209789), the upper limit being the largest fluctuation recorded anywhere in the solar pond area prior to the spring of 1995. These fluctuations indicate that the surficial deposits are

responsive to recharge events and are hydrologically active. The pattern of fluctuations suggest that the most active areas are related to a more favorable recharge environment (flat, undeveloped bare soils) compared to adjacent, relatively impervious industrial areas associated with the solar ponds and 700 building complex. Construction of a WMF in this area would likely reduce the degree of fluctuations due to a reduction in permeable recharge area.

Minimum depths to water (historical highs) were recorded during May and June of 1995. Groundwater levels during this period ranged from 1.0 to 4.8 feet below ground level. The deeper water levels tend to occur near the north, south, and east boundaries of the IHSS 165 area (edge of Rocky Flats alluvium). Shallower groundwater (wells P207889 and P209789) is found toward the center where the highest water table fluctuations have been recorded. Spring precipitation for 1995 has been estimated to be the wettest in a 102 year period based on precipitation records from Boulder, Colorado.

Groundwater Flow Direction

Horizontal

From the available potentiometric maps generated for OU4 and OU6, alluvial groundwater is depicted as flowing primarily to the northeast, southeast and east toward the Walnut and South Walnut Creek drainages (see Figure II.3.3-49 attached). In thinly saturated areas, the bedrock surface configuration is considered to have the major controlling influence on groundwater flow direction. Narrow preferential pathways are defined by bedrock surface paleochannels (scour channels), most notably a northeast-southwest trending channel that traverses the center of the site and discharges toward Pond A-1. The presence of additional scour channels at IHSS 165 have been presented in the OU4 and OU6 draft RI/RFI reports, however these features are based on limited data and must be considered speculative at this point in time.

Horizontal groundwater flow is also possible in the weathered bedrock, particularly in the Arapahoe No. 1 sandstone, which subcrops beneath the alluvium along the eastern end of IHSS 165. Groundwater in the overlying alluvium has the potential to recharge the No. 1 sandstone, which due to its discontinuous nature, could invariably change the direction of flow. Little information exists that permits an evaluation of groundwater flow in sandstone at the site, although experience with the Arapahoe No. 1 sandstone at OU2 has demonstrated the potential hydrologic importance of this unit as a contaminant pathway.

Vertical

Downward vertical groundwater flow is known to occur from the alluvium to the weathered bedrock at IHSS 165, but is thought to be limited relative to lateral flow. An exception to this situation might exist at the subcrop areas of the No. 1 sandstone. The solar pond fault, aka. fault 3, is located west of the IHSS 165 boundary and, therefore, is not considered to be a concern for groundwater flow.

Aquifer Properties

Values for alluvial and bedrock hydraulic conductivity are lacking in the IHSS 165 area. There is, however, no reason to believe that the hydraulic properties of the alluvial and bedrock materials in this area are atypical of similar settings to the south and west.

Summary statistics for site-wide hydraulic conductivity data reported in the 1995 Hydrogeologic Characterization Report are as follows:

Unit	Geometric Mean (cm/sec)	Range Minimum (cm/sec)	Range Maximum (cm/sec)
Rocky Flats Alluvium	2.1×10^{-4}	7.1×10^{-8}	5.0×10^{-2}
No. 1 SS	7.9×10^{-4}	4.0×10^{-5}	9.3×10^{-3}
Weathered Claystone	8.8×10^{-7}	3.0×10^{-8}	5.6×10^{-4}

The closest well tests for the Rocky Flats alluvium are well 2686 (2.0×10^{-5} cm/sec) and 2886 (6.8×10^{-7} cm/sec), both located at the solar pond area. Additional Rocky Flats alluvium hydraulic conductivity data determined by the BAT piezometer tip method and reported in the OU4 report indicates very low values in the 10^{-7} to 10^{-10} cm/sec range. These reported values are suspect and should not be considered representative of actual hydraulic conductivities in this area. No values exist for the No. 1 sandstone at the site.

Adequacy of Existing Hydrogeologic Database

Given the divergent nature of flow in the alluvium and (probably) bedrock, interconnectiveness of shallow water-bearing units and expected variable upgradient groundwater quality, a relatively large number of wells will be required to adequately monitor up and downgradient groundwater quality of the WMF. An estimated total of seventeen wells (seven alluvial, six non-sandstone weathered bedrock and four No. 1 sandstone wells) may be required for compliance monitoring based on a worst case scenario in which all three units are treated as contaminant pathways. Figure II.3.5-1 shows the basic network monitoring wells described in more detail below.

A breakdown of the estimated compliance monitoring and siting characterization well requirements for the facility are as follows:

Geologic Unit	Existing Compliance Wells	New Compliance Wells	New Characterization Wells
RFA	5	2	0
Weathered Bedrock	2	4	0
No. 1 SS	0	4	2 to 4

Well and borehole coverage at IHSS 165 is generally adequate to characterize the alluvium for siting purposes, but additional wells (at least two for planning purposes) may be required for compliance monitoring of a new WMF. The actual location and size of the facility will determine how many existing wells survive after construction and how many additional wells will be required for filling gaps in the monitoring well network. Better definition of scour channels is viewed as the main priority.

Information adequate for characterizing the nature and extent of the weathered bedrock groundwater system is currently lacking. Knowledge of the geometry and basic hydrogeology

(i.e. groundwater flow direction, hillside discharge locations, saturated thickness, etc.) of the weathered bedrock, and in particular the No. 1 sandstone, is critical to understanding groundwater conditions at the site and designing an effective groundwater monitoring program. The importance of the No. 1 sandstone as a potential contaminant pathway has already been demonstrated in the OU2 area of the plant. It is expected that a bedrock groundwater characterization siting study and monitoring plan will be required to address the potential for contaminant migration through bedrock materials, given the presence of groundwater in the weathered zone and No. 1 sandstone. As many as 8 wells drilled to the base of the weathered zone may be required to characterize and monitor the weathered bedrock groundwater system. The ultimate number of wells will depend on the complexity of the bedrock system and extent of the No. 1 sandstone beneath the WMF. It is possible that the number of bedrock wells could be reduced by utilizing surface geophysical and/or geoprobe technology to define the extent of the No. 1 sandstone and site optimum monitoring well locations.

rgs

Attachments:
As Stated

cc:
W. R. Belcher
T. P. Lovseth
ERPD Record (2)

Attachment #1
RGS-013-95
November 22, 1995
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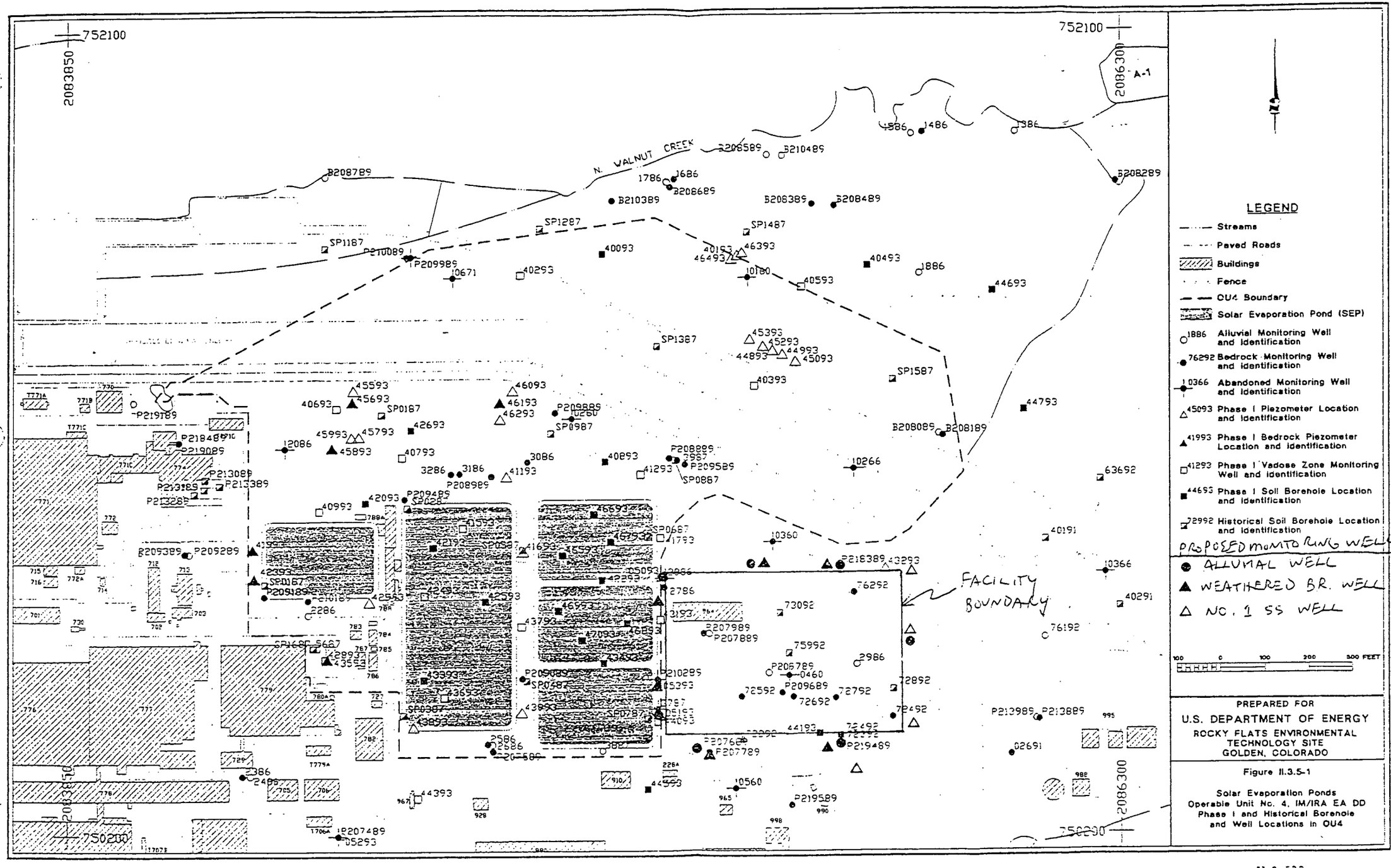

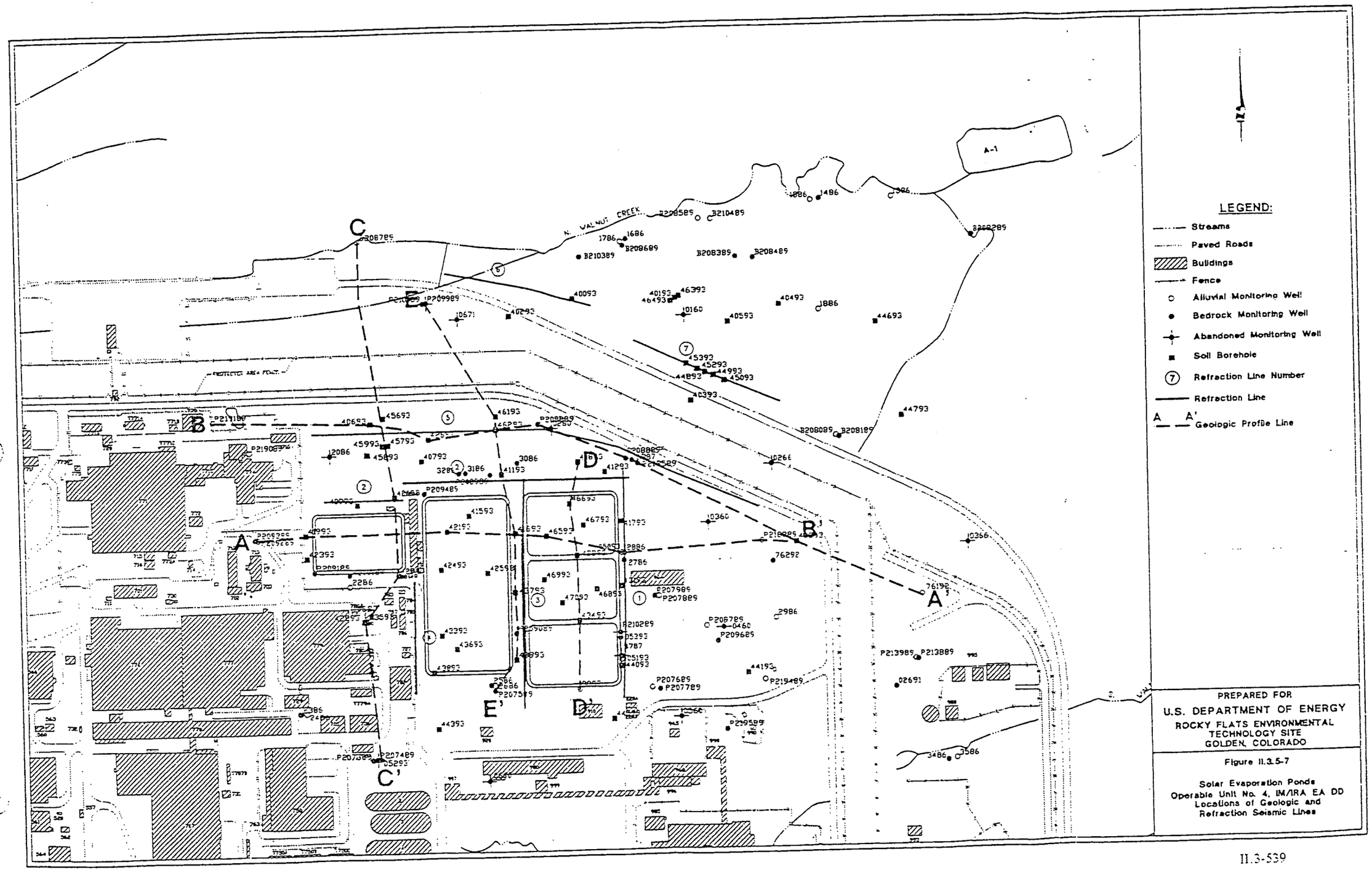

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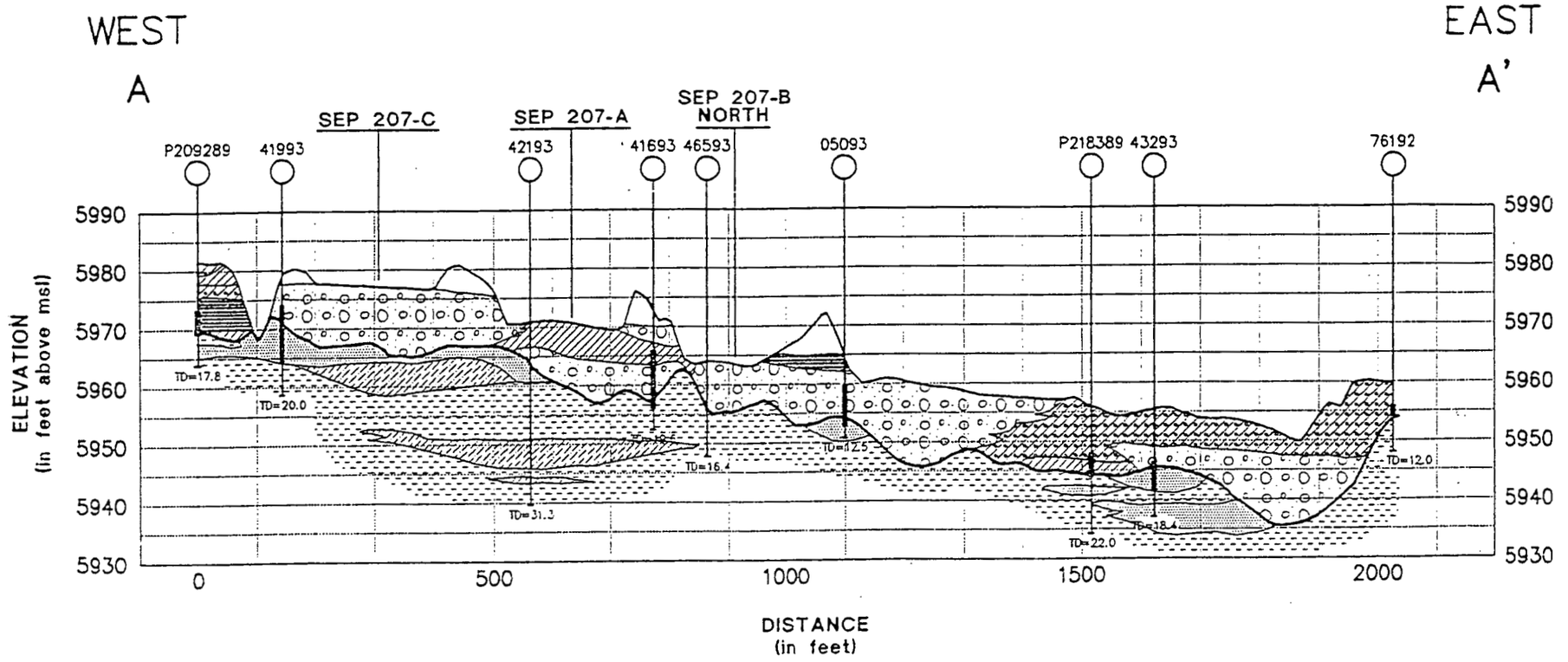
Figure II.3.5-7

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Locations of Geologic and Refraction Seismic Lines



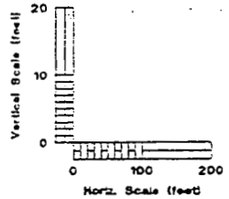
LEGEND

UNCONSOLIDATED MATERIALS

- Sandy Lithofacies
- Sandy Gravel Lithofacies
- Clayey Silty Gravel Lithofacies
- Clayey & Silty Lithofacies
- Artificial Fill or Colluvium

BEDROCK

- Sandstone
- Siltstone
- Claystone
- Screened Interval
- Borehole/Well No.
- Bedrock - Unconsolidated Materials Contact



Note: Vertical Exaggeration 10x

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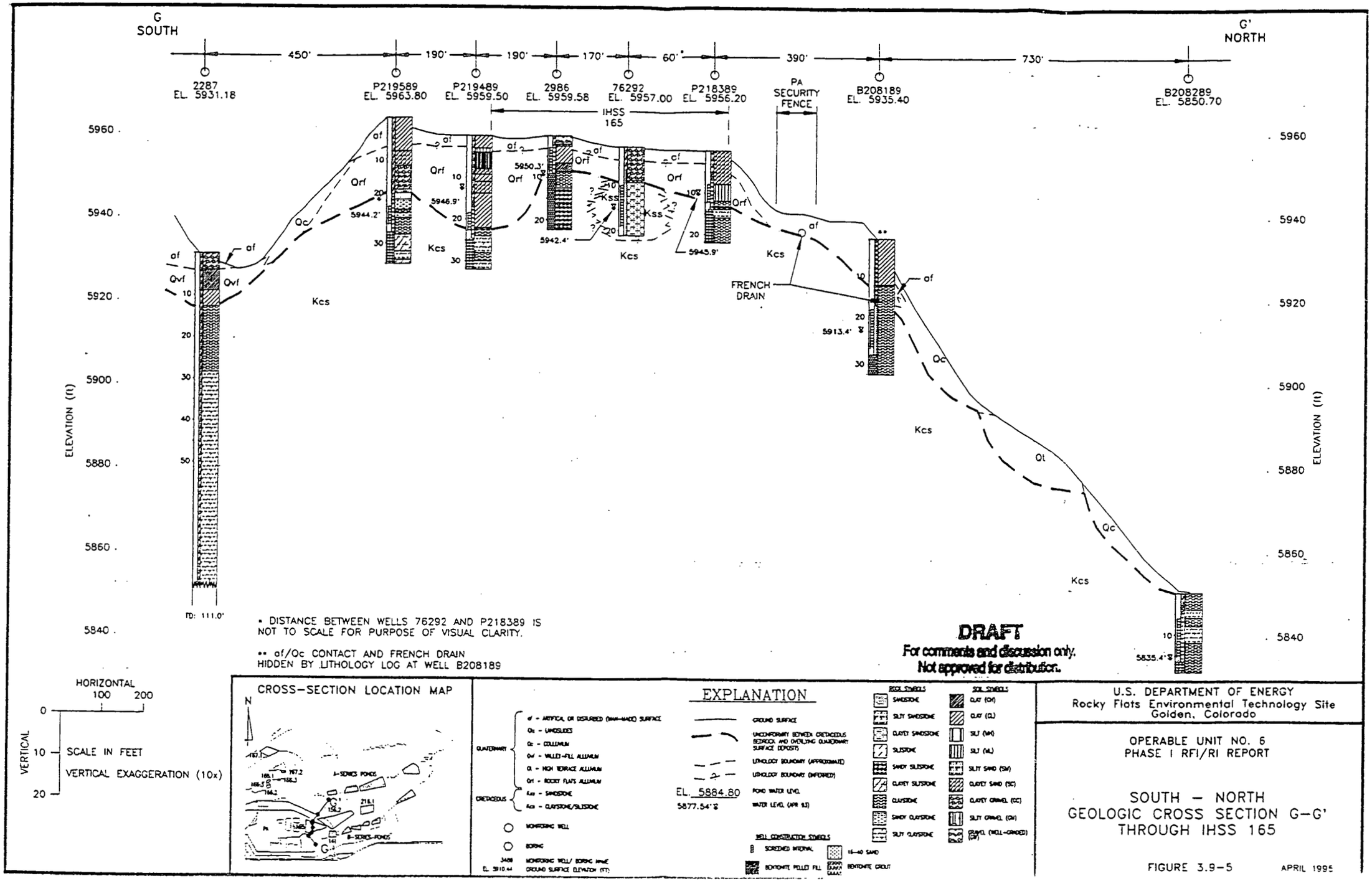
Figure II.3.5-8

Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Alluvium and Bedrock Cross-Section A-A'



U.S. DEPARTMENT OF ENERGY
Rocky Flats Environmental Technology Site
Golden, Colorado

OPERABLE UNIT NO. 6
PHASE I RFI/RI REPORT

SOUTH – NORTH GEOLOGIC CROSS SECTION G–G' THROUGH IHSS 165

FIGURE 3.9–5 APRIL 1995

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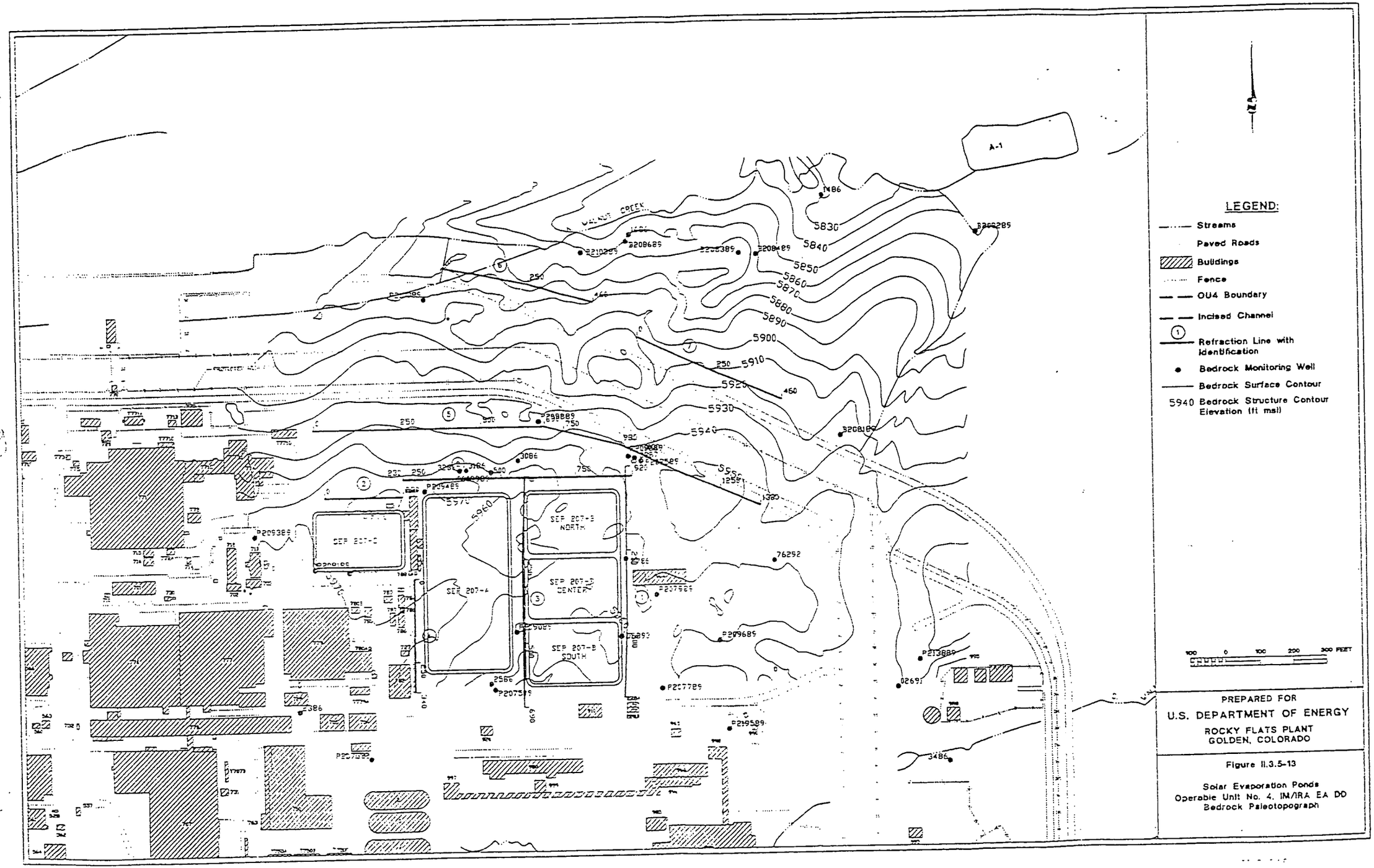

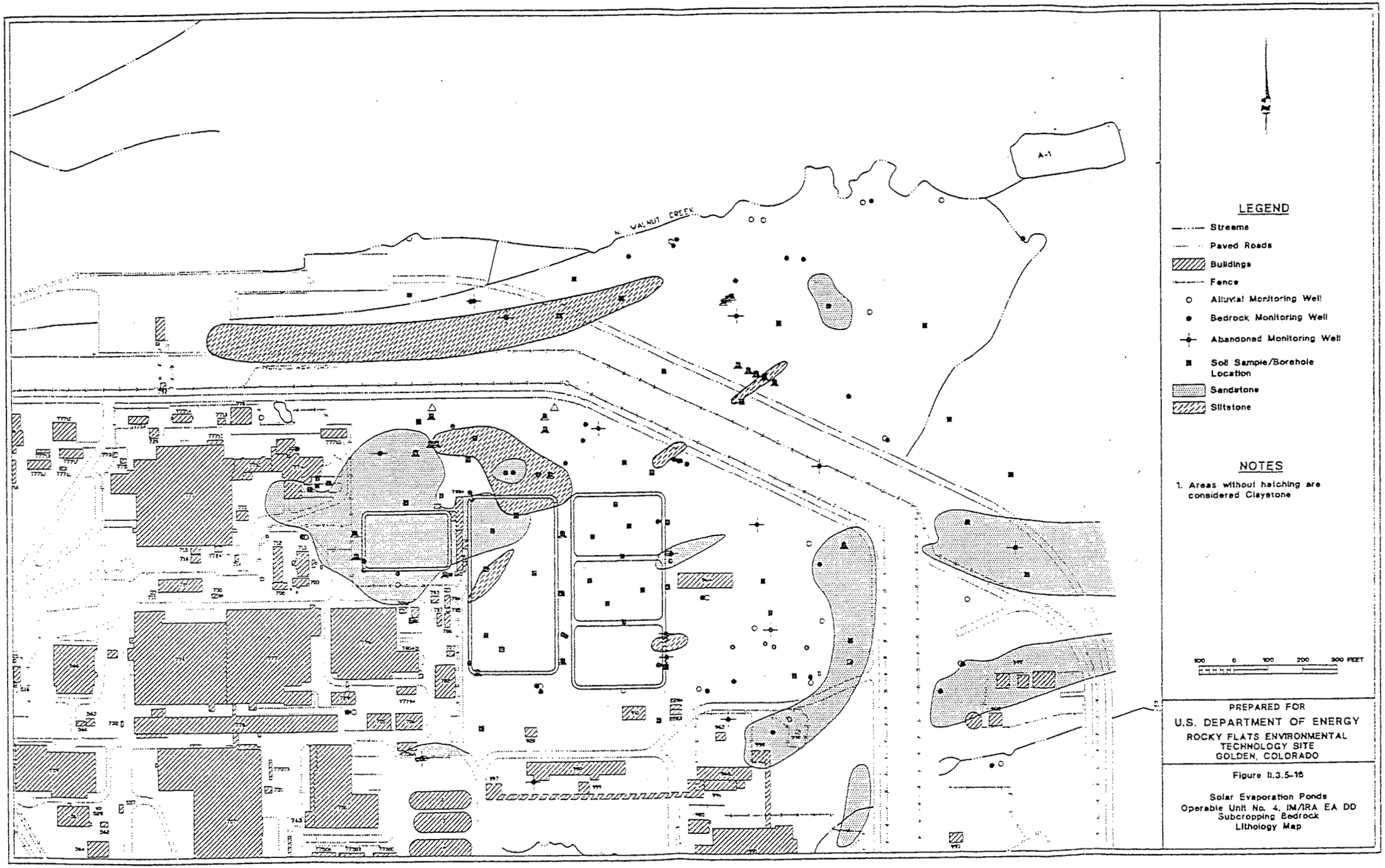
N. WALNUT CREEK
A-1
LEGEND
Streams
Paved Roads
Buildings
Fence
Alluvial Monitoring Well
Bedrock Monitoring Well
Abandoned Monitoring Well
Soil Sample/Borehole Location
Sandstone
Siltstone
NOTES
1. Areas without hatching are considered Claystone
100 0 100 200 300 FEET
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Figure II.3.5-16
Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Subcropping Bedrock
Lithology Map

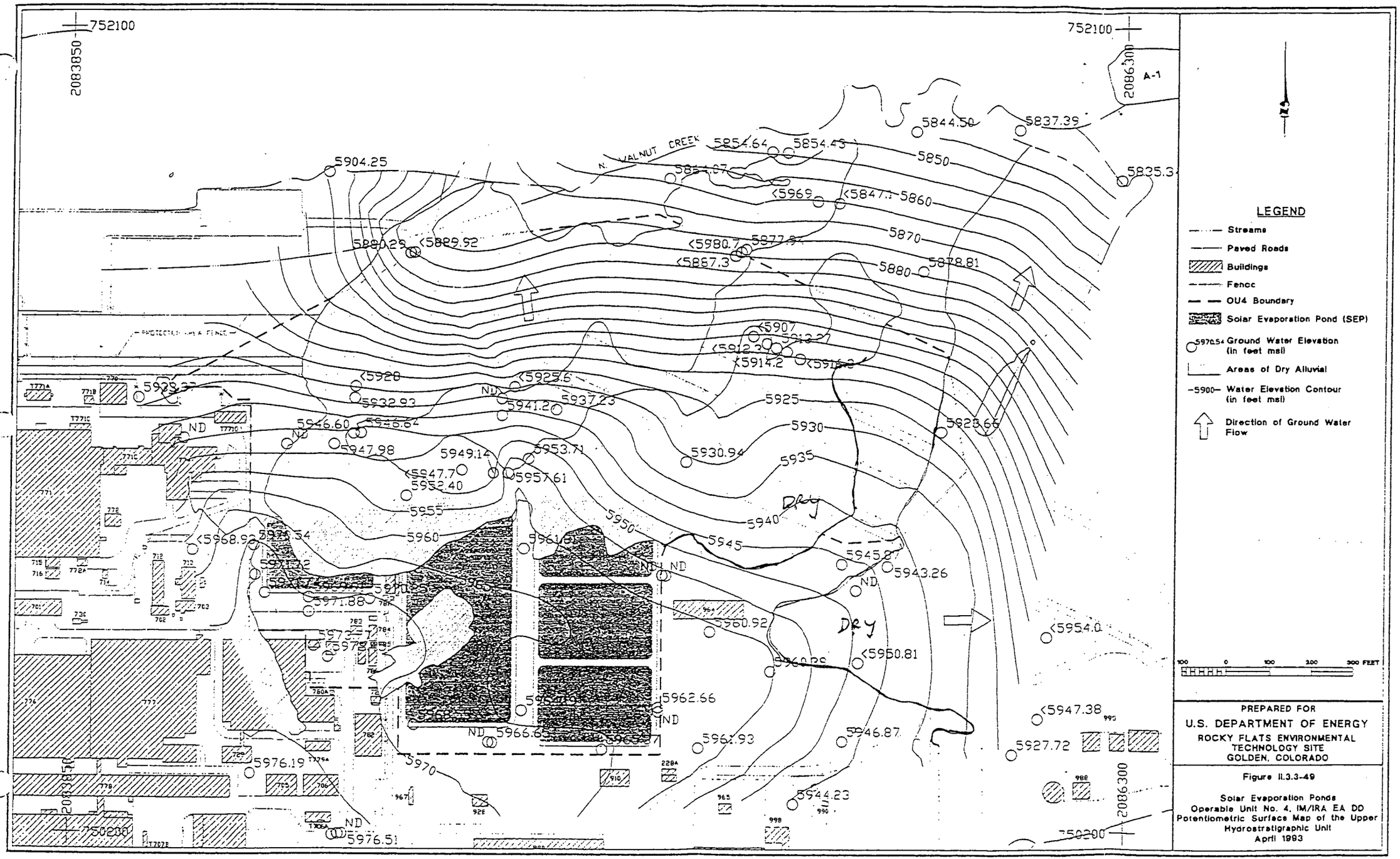
752100
2083850
2086300
A-1
N. WALNUT CREEK
5904.25
5844.50
5837.39
5854.64
5854.43
5850
5835.3
5860
5870
5880
5878.81
5880.29
5889.92
5980.7
5867.3
5907
5928
5925.6
5932.93
5941.20
5937.23
5925
5930
5923.66
5946.60
5946.64
5947.98
5949.14
5953.71
5930.94
5935
5947.7
5952.40
5957.61
5955
5940
DRY
5950
5960
5945
5945.87
5943.26
5968.92
5971.88
5960.92
DRY
5950.81
5954.0
5962.66
5966.65
5947.38
5927.72
5961.93
5946.87
5976.19
5970
5944.23
5976.51
ND
LEGEND
Streams
Paved Roads
Buildings
Fence
OU4 Boundary
Solar Evaporation Pond (SEP)
5970.54 Ground Water Elevation (in feet msl)
Areas of Dry Alluvial
-5900- Water Elevation Contour (in feet msl)
Direction of Ground Water Flow
100 0 100 200 300 FEET
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Figure II.3.3-49
Solar Evaporation Ponds
Operable Unit No. 4, IM/IRA EA DD
Potentiometric Surface Map of the Upper Hydrostratigraphic Unit
April 1993